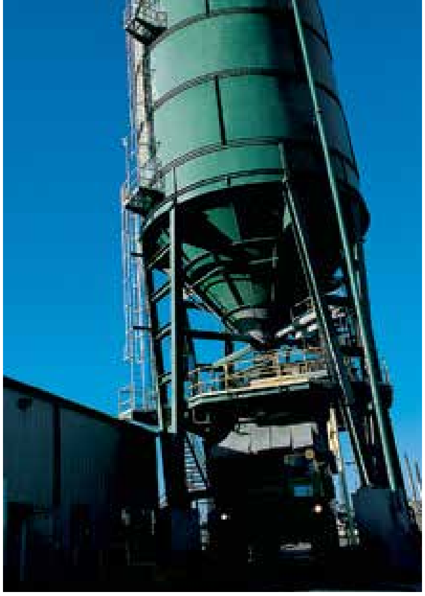
ISSUE 1 • 2013

ASH at work

Applications, Science, and Sustainability of Coal Ash

Special Section:
Beneficial Use of Coal Combustion Products: An American Recycling Success Story

PLUS:
Rare Earth Metals in Coal Ash
Ash for Asphaltic Concrete Paving
ACAA Champion Award
And much more…

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On the Cover

World of Coal Ash 2013 drew attendees from 20 countries for an array of scientific and social activities.

BYLAWS MATTER

By Thomas H. Adams, Executive Director ACAA

Bylaws are the "constitution" of an organization. They define who the organization is, what it is intended to do, and how it should accomplish its mission. Organizations such as the American Coal Ash Association (ACAA) *must* have bylaws for a variety of very good reasons. Besides being required by law, the bylaws provide a structure for governance and define membership requirements. Anyone interested in becoming a member or learning how the association is managed can find that information in the bylaws. Well-written bylaws are a very valuable asset, as they provide clarity and protect the assets of the association as well as the volunteers who serve. Poorly written bylaws provide a platform for disaster, producing confusion in governance and leaving volunteers and assets exposed to some serious problems.

Healthy organizations take time to consider their bylaws before a crisis is knocking on the door. Responsible leadership periodically conducts a review to see if the bylaws match the needs of the members. *"If it ain't broke, don't fix it."* That advice is applicable to bylaws as well. But when a review identifies areas that need to be revised, it is prudent to identify and discuss opportunities to improve the association's structure and management.

This past September, the members of ACAA approved revisions in the association's bylaws. The approval was the culmination of a long process of review, analysis, and discussion prior to balloting the proposed revisions. The process was initiated under the leadership of Mark Bryant. Bryant was Chair of the ACAA Board of Directors when the first discussions took place. He was committed to this process and continued to provide leadership even after his term as Chair expired. Along with Hollis Walker, current Vice Chair of the ACAA Board of Directors, the structure of the organizational governance and membership categories was closely examined with the Executive Committee and Board of Directors. Together, Bryant and Walker worked closely with expert legal counsel from Miller Canfield, PLC, in reviewing the current bylaws and proposed changes. Proposed changes were brought to ACAA membership in a variety of forms: membership meetings, conference calls, and e-mails. The final balloting had no negative votes.

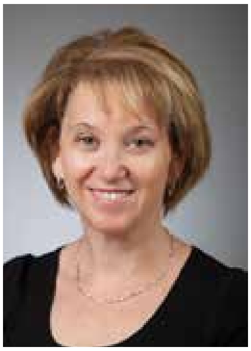
In addition to Bryant and Walker, significant input and oversight was provided by Lisa Cooper, Chair of the Board of Directors; Charles Price, Secretary/Treasurer; Laurie Cook; Art Covi; and Fred Gustin. Thank you for the long hours put into this project.

Some of the most significant changes made in this revision to the bylaws include the following:

- All members vote. Nonvoting status is eliminated. This change will affect the membership dues of some members. As in the past, affiliate members are not eligible to vote.
- Each member company appoints a representative to be known as a "member delegate."
- Member delegates elect the Officers and Board of Directors.
- The Board of Directors will be comprised of 17 members. Those on the Board will include the Chair; Vice Chair; Secretary/Treasurer; Chairs of the three standing committees (Communications and Membership, Government Relations, and Technical); and nine at-large members. The at-large seats will be allocated as follows: four for utility members, three for marketing members, and two for associate members. Each at-large segment will elect its own Board members. The immediate past Chair and the Executive Director are nonvoting members of the Board of Directors.
- The Executive Committee will be comprised of the Chair, Vice Chair, and Secretary/Treasurer. The Executive Director is a nonvoting member of the Executive Committee. The Executive Committee will provide oversight of daily association management and act on matters as specifically directed and authorized by the Board of Directors.

Election of the new slate of officers and directors will take place at the ACAA Winter Meeting in Albuquerque, NM, February 4-5, 2014. The new officers and directors will begin their terms of service at the close of the Summer 2014 meeting, thereby completing the transition.

The completion of the review and revision of our bylaws is a major accomplishment. I believe the revisions will help make ACAA a more efficient, effective organization.



STATE OF THE ASSOCIATION

By Lisa Cooper, ACAA Chair

The American Coal Ash Association is facing a pivotal moment in the history of coal combustion product (CCP) use. It's a good time to ask ourselves whether or not we are prepared.

For the past 5 years, our industry has been besieged by regulatory uncertainty and a battle to prevent an unwarranted and damaging "hazardous waste" designation for coal ash.

For the past 5 years, our industry has been besieged by regulatory uncertainty and a battle to prevent an unwarranted and damaging "hazardous waste" designation for coal ash. For a small association like ours, the challenge has been, at times, daunting.

Many thousands of volunteer hours have been expended by our members in preparing and submitting comments to government agencies, attending hearings and meetings, petitioning elected officials for help, reassuring users of CCPs regarding their efficacy and safety, and responding to a steady stream of misleading publicity.

Finally, in 2013, we began to see some light at the end of the tunnel—and no, it wasn't another oncoming train. The U.S. Environmental Protection Agency (EPA) signaled that its "current thinking" is that nonhazardous regulation of coal ash disposal is appropriate. A bill that would regulate ash disposal as nonhazardous passed the U.S. House of Representatives and went to the Senate covered by cooperative statements from the White House. A lawsuit to force the EPA to conclude its rulemaking activities (brought in part by ACAA members Headwaters Resources and Boral Material Technologies) resulted in the court mandating that the EPA set a deadline.

We now face the real possibility that—either by regulation or legislation—the regulatory uncertainty that has plagued us may be resolved in our favor in the next year or so. So, are we equipped to move on to the next step?

I'm pleased to report that we are. Despite the distractions of the past half-decade, ACAA has made meaningful progress in strengthening the core of our organization:

- We have strong mid- and back-office support from our new association management company.
- We have strong volunteer leadership. During our last election, we had a panel of candidates that was not only impressive but also plentiful—no arms had to be twisted.
- We have strong professional leadership.
- We are financially strong.
- We are adding membership.
- We have new, modern by-laws.

Don't give up the fight and fight hard to protect the safe recycling of CCPs because it is the right thing to do for the environment, the industry, and America's future.

This remarkable progress is the result of the dedication of our members. Our membership believes strongly in our mission! Since our last conference, I have had several calls from members who were going to be displaced from their jobs. All had the same message: Don't give up the fight and fight hard to protect the safe recycling of CCPs because it is the right thing to do for the environment, the industry, and America's future.

Mission No. 1 for our association remains getting clarity that CCPs will not be regulated as hazardous waste. We will not let up on that goal. But as we achieve that goal, we must move immediately to shore up our product's brand and address technical issues for CCP users.

We must engage fully in the important work of promoting coal ash use. We must reassure CCP users that adequate supply will exist and they shouldn't look for other building materials. If we bring to this effort the same level of energy and tenacity that we have displayed over the past 5 years, it will be an effort sure to succeed. ❖

WORLD OF COAL ASH 2013

Lexington, KY, Hosts Record Attendance for International Event

A record 591 people representing 20 countries attended the World of Coal Ash (WOCA) symposium in Lexington, KY, in 2013. WOCA is a biennial international event hosted by the University of Kentucky Center for Applied Energy Research and the American Coal Ash Association.

The 2013 program included more than 40 sessions and 140 presentations, an exhibition area with more than 60 exhibit booths, and social activities. New to the conference's topical areas were two liquefaction sessions. Additionally, there was a large contingency of pond topic-related sessions, including two sessions from the Kingston researchers regarding the findings from ecological investigations and the results in CERCLA and NRDA processes.

Papers presented at WOCA are available online at the Center for Applied Energy Research's "Ash Library" at **www.flyash.info**.

HONORS AND AWARDS

The 2013 Barton A. Thomas Memorial Award for Excellence in the Field of Ash Research is presented to the Best Oral Presentation at the WOCA conference. The conference attracted a number of outstanding presentations, making the competition for the award quite rigorous. The presentation and paper titled "Weathering and Leaching Characteristics of a Fixated Scrubber Sludge Cap at an Abandoned Mine Site in Pike County"—delivered by Tracy Branam, Luke Martin, Shawn Naylor, and Greg Olyphant of Indiana University and Indiana Geological Survey—was judged to be the one most worthy of this award.

L.W. Quo, Taiwan Power Company, Republic of China, won the WOCA Poster Award sponsored by the Electric Power Research Institute. Andrew J. Salber, Tufts University, won the WOCA Student Poster Award sponsored by the ACAA Educational Foundation. Jian Ding, Chinese Academy of Sciences, and Jenet Hattaway, UNC Charlotte, won the WOCA Student Presentation Award sponsored by the Midwest Coal Ash Association.

Additionally, the Midwest Coal Ash Association awarded $500 stipends to six students. They included Brian Dudley, The Ohio State University; Tristana Duvallet, University of Kentucky CAER; Kevin Foster, Virginia Tech; Mina Mohebbi, Pennsylvania State University; Derek Pruyne, Pennsylvania State University; and Nathan Yencho, The Ohio State University.

SAVE THE DATE

The next World of Coal Ash—WOCA 2015—will be held in Nashville, TN, May 4-8, 2015. The Nashville Renaissance Hotel will host the biennial conference.

Thank you, WOCA 2013 Sponsors and Exhibitors!

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Bruce Watzman, representing the National Mining Association, was a plenary session speaker regarding the future of coal use in the United States.

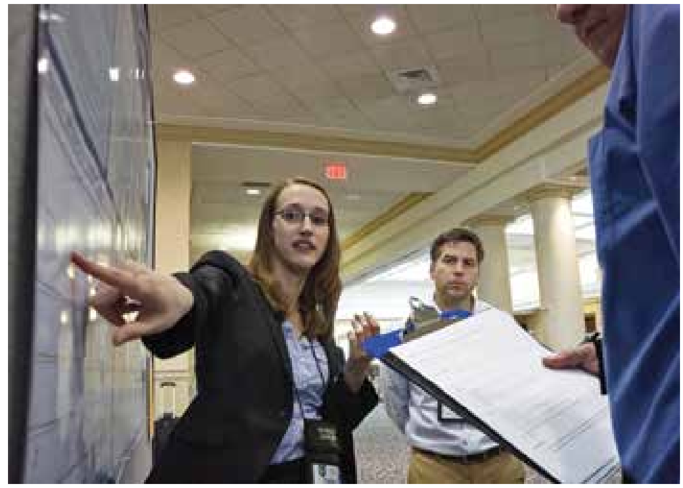
Craig Heidrich, CEO of the Ash Development Association of Australia, briefed plenary session attendees regarding work of the World Wide Coal Combustion Products Network.

See more photos from WOCA 2013 online at www.worldofcoalash.org/photos/woca2013photos.html.

Exhibitors

Agru America
Allen-Sherman-Hoff
AMEC Environment & Infrastructure, Inc.
American Coal Ash Association (ACAA)
ARCADIS
The ARM Group
Beneficial Reuse Management
CDM Smith
CEC—Civil & Environmental Consultants, Inc.
CETCO
Charah
Chesapeake Containment Systems, Inc.
Claisse, Corporation Scientifique
Clyde Bergemann Power Group
Coal Combustion Inc. (CCI)
COMANCO Environmental Construction Corp.
Conestoga-Rovers & Associates
DustMaster Enviro Systems
ENTACT Environmental Services
Environmental Specialties International, Inc.
FLSmidth Inc.
GAI Consultants
GEA EGI Contracting / Engineering Co. Ltd.
GeoSupply Soil Solutions
Geosyntec Consultants
Geotechnics, Inc.
Green Ash Alliance LLC
GSE Environmental
Haley & Aldrich, Inc.
Hallaton Containment Linings
Hanson Professional Services, Inc.
Headwaters Resources
Henderson
Hull & Associates, Inc.
Joyce Engineering
Lancaster Products
LB Industrial Systems
Lhoist North America
Morgan Corp.
MWH Americas, Inc.
Orbite Aluminae Inc.
Pressure Tech
River Consulting
Saiia Construction, LCC
SCS Engineers
The SEFA Group
Site Supply, Inc.
S&ME
Stantec Consulting Services, Inc.
SYNMAT—Synthetic Materials
Tank Connection
Test America
Tetra Tech, Inc.
TRANS-ASH
UNC Charlotte Dept. of Civil and Environmental Engineering
United Conveyor Corporation
Utter Construction, Inc.
VEOLIA Environmental Services
WL Port-Land Systems, Inc.
WM Waste Management
Wyoming Analytical Labs
University of Kentucky Center for Applied Energy Research

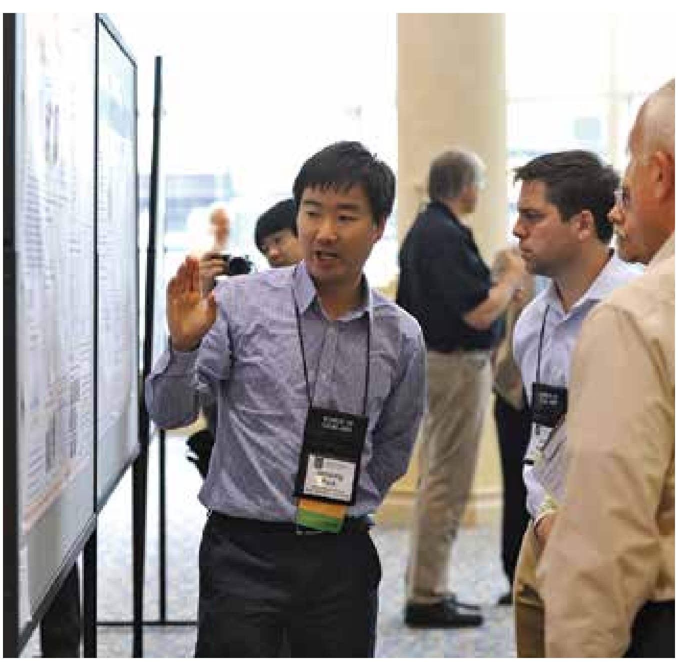
U.S. Congressman David McKinley of West Virginia, sponsor of legislation to create nonhazardous coal ash disposal regulations in the United States, also addressed the plenary session audience.



Tristana Duvallet of the University of Kentucky also won a $500 stipend from the Midwest Coal Ash Association.

Mina Mohebbi of Pennsylvania State University explains her poster exhibit. Mohebbi won a $500 stipend from the Midwest Coal Ash Association for her work.

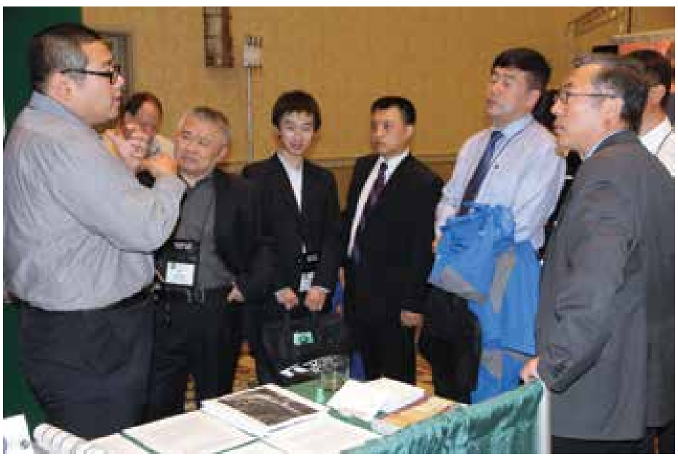
Plenary session speakers attracted a standing-room-only crowd.



Jaesung Park of Seoul National University in South Korea presents his research.

Center for Applied Energy Research personnel mingle with conference attendees.

The Exhibit Hall was a popular meeting place for WOCA attendees.

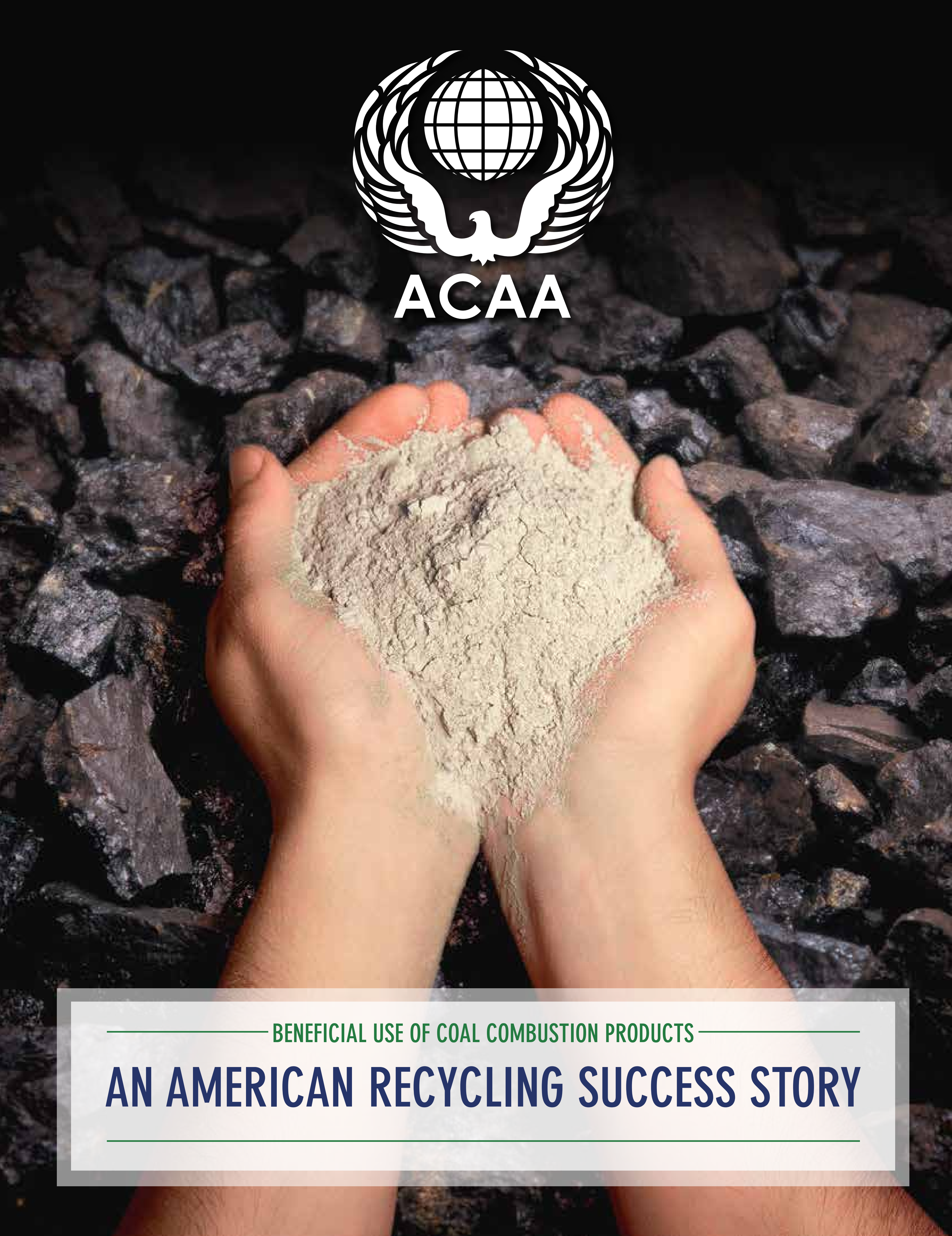


International delegates to the conference visit one of more than 60 exhibitors on hand.

Social receptions attracted large crowds of attendees.

Conference learning opportunities included paper presentations, poster exhibits, and an in-depth short course.

No visit to Kentucky would be complete without sampling the fine local whiskey.



ACAA

BENEFICIAL USE OF COAL COMBUSTION PRODUCTS

AN AMERICAN RECYCLING SUCCESS STORY

The American Coal Ash Association *was established in 1968 as a trade organization devoted to recycling the materials created when we burn coal to generate electricity. Our members comprise the world's foremost experts on coal ash (fly ash and bottom ash), and boiler slag, flue gas desulfurization gypsum or "synthetic" gypsum, and other "FGD" materials captured by emissions controls. While other organizations focus on disposal issues, ACAA's mission is to advance the management and use of coal combustion products in ways that are: environmentally responsible; technically sound; commercially competitive; and supportive of a sustainable global community.*

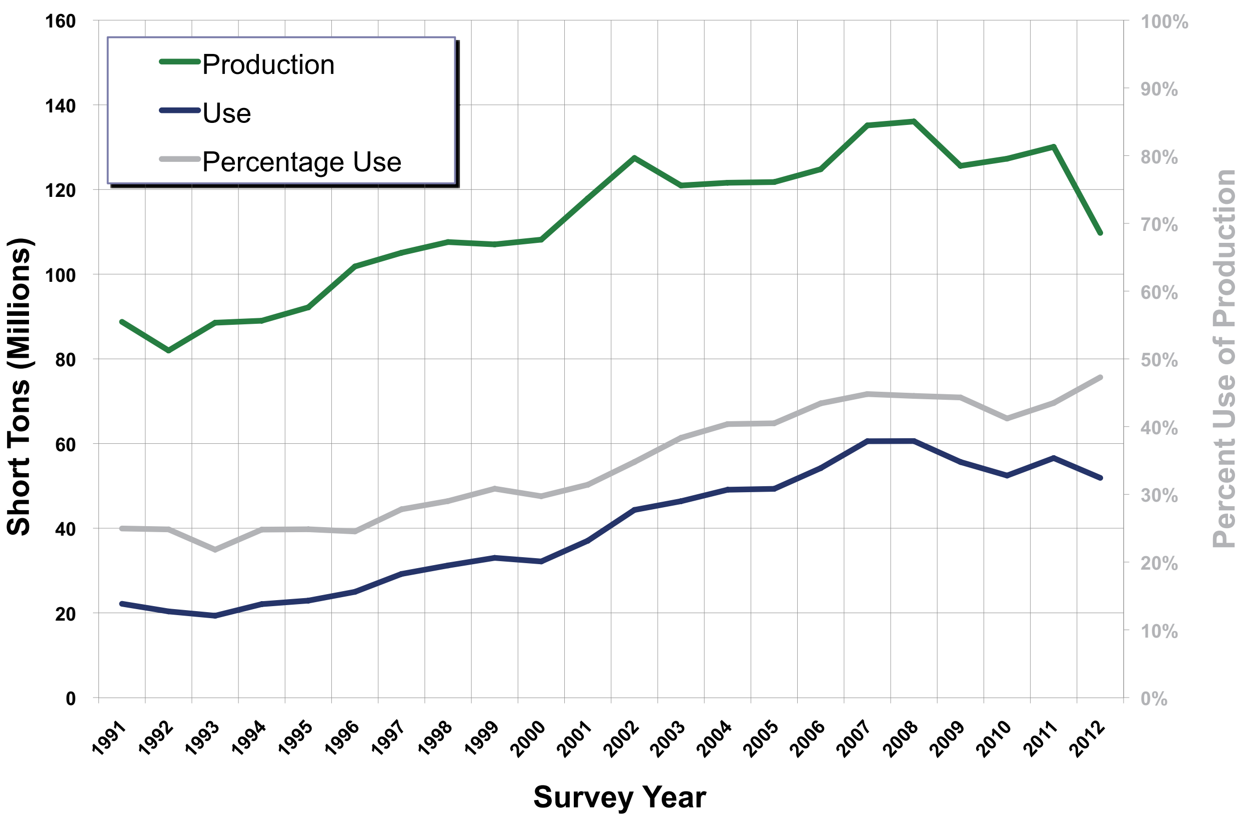
AN AMERICAN RECYCLING SUCCESS STORY

Coal Combustion Products – also referred to as "coal ash" – are solid materials produced when coal is burned to generate electricity. There are many good reasons to view coal ash as a resource, rather than a waste. Recycling it conserves natural resources and saves energy. In many cases, products made with coal ash perform better than products made without it.

As coal continues to be the largest energy source for electricity generation in the United States, significant volumes of coal ash are produced. Since 1968, the American Coal Ash Association has tracked the production and use of all types of coal ash. These surveys are intended to show broad utilization patterns and ACAA's data have been accepted by industry and numerous government agencies as the best available metrics of beneficial use practices.

In 2012, coal ash utilization remained below 2008 levels for a fourth consecutive year in the face of decreasing coal use, general economic stagnation, and regulatory uncertainty regarding the federal classification of ash. This follows eight years of dramatic growth in coal ash beneficial use during a period of regulatory certainty.

CCP Production & Use (1990 - 2012)



ACAA

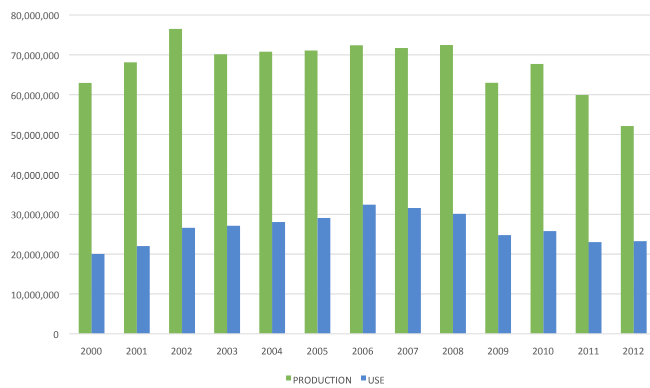
Fly Ash

Fly ash is a powdery material that is captured by emissions control equipment before it can “fly” up the stack. Mostly comprised of silicas, aluminas and calcium compounds, fly ash has mechanical and chemical properties that make it a valuable ingredient in a wide range of concrete products. Roads, bridges, buildings, concrete blocks and other concrete products commonly contain fly ash.

Concrete made with coal fly ash is stronger and more durable than concrete made with cement alone. By reducing the amount of manufactured cement needed to produce concrete, fly ash accounts for about 10 million tons of greenhouse gas emissions reductions each year.

Other major uses for fly ash include constructing structural fills and embankments, waste stabilization and solidification, mine reclamation, and use as raw feed in cement manufacturing.

Fly Ash Production & Use 2000 – 2012



Fly ash ranges in color from gray to buff depending on the type of coal.

The American Road & Transportation Builders Association estimates coal fly ash use in roads and bridges saves $5.2 billion per year in U.S. construction costs.

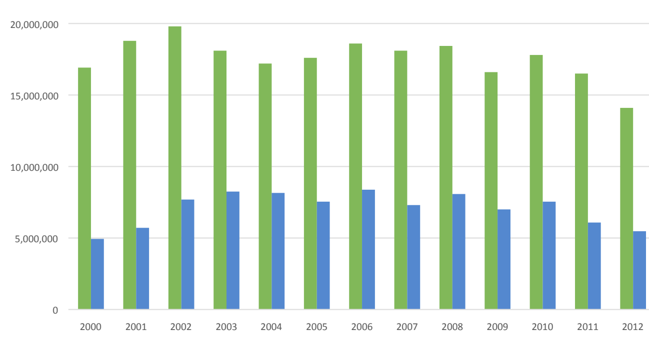
Bottom Ash

Bottom ash is a heavier, granular material that is collected from the “bottom” of coal-fueled boilers. Bottom ash is often used as an aggregate, replacing sand and gravel. Bottom ash is often used as an ingredient in manufacturing concrete blocks.

Other major uses for bottom ash include constructing structural fills and embankments, mine reclamation, and use as raw feed in cement manufacturing.

Bottom ash can be used in asphalt paving.

Bottom Ash Production & Use 2000 – 2012



Bottom ash is a granular material suitable for replacing gravel and sand.

Synthetic Gypsum

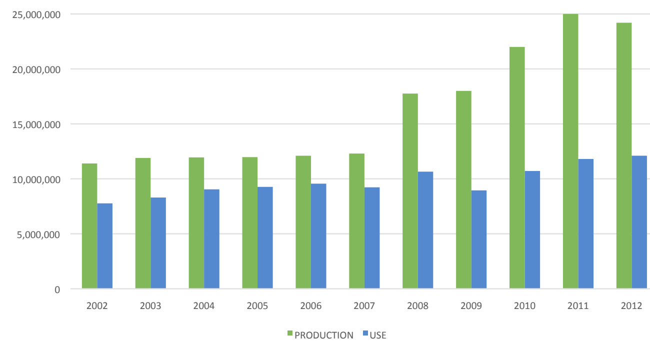
Power plants equipped with flue gas desulphurization ("FGD") emissions controls, also known as "scrubbers," create byproducts that include synthetic gypsum. Although this material is not technically "ash" because it is not present in the coal, it is managed and regulated as a coal combustion product and referred to generically as a form of coal ash.

Scrubbers utilize high-calcium sorbents, such as lime or limestone, to absorb sulfur and other elements from flue gases. Depending on the scrubber configuration, the byproducts vary in consistency from wet sludge to dry powdered material.

Synthetic gypsum is used extensively in the manufacturing of wallboard. A rapidly growing use of synthetic gypsum is in agriculture, where it is used to improve soil conditions and prevent runoff of fertilizers and pesticides.

Other major uses for synthetic gypsum include waste stabilization, mine reclamation, and cement manufacturing.

Synthetic Gypsum Production & Use 2002 – 2012



Synthetic gypsum is often more pure than naturally mined gypsum.

Approximately 40 percent of the gypsum wallboard manufactured in the United States utilizes synthetic gypsum from coal-fueled power plants.

Synthetic gypsum applied to farm fields improves soil quality and performance.

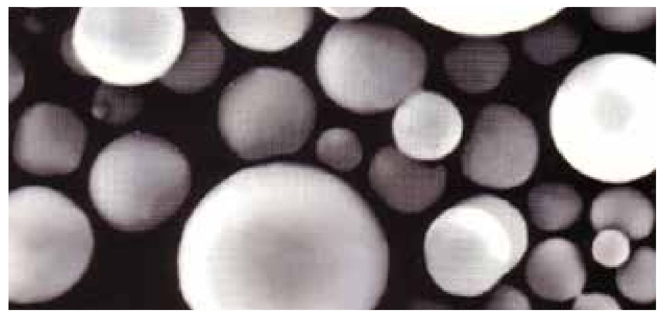
ACAA

Other Products and Uses

Boiler Slag – is a molten ash collected at the base of older generation boilers that is quenched with water and shatters into black, angular particles having a smooth, glassy appearance. Boiler slag is in high demand for beneficial use as blasting grit and roofing granules, but supplies are decreasing because of the retirement from service of older power plants that produce boiler slag.

Nearly 90 percent of all boiler slag is beneficially used.

Cenospheres – are harvested from fly ash and are comprised of microscopic hollow spheres. Cenospheres are strong and lightweight, making them useful as fillers in a wide variety of materials including concrete, paint, plastics and metal composites.



Because of their high value, cenospheres – seen here in a microscopic view – are measured by the pound rather than by the ton.

FBC Ash – is a category of ash from Fluidized Bed Combustion power plants. These plants reclaim waste coal for fuel and create an ash by-product that is most commonly used to reclaim abandoned surface mines and abate acid mine drainage. Ash from FBC power plants can also be used for waste and soil stabilization.

New Uses on Horizon

New beneficial uses for coal ash are continually under development. Researchers and ash marketers are currently focusing heavily on the potential for reclaiming ash that has already been disposed for potential beneficial use. There is also renewed interest in the potential for extracting strategic rare earth minerals from ash for use in electronics manufacturing.

ACAA

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2012 Coal Combustion Product (CCP) Production & Use Survey Report

Beneficial Utilization versus Production Totals (Short Tons)									
2012 CCP Categories	**Fly Ash****	**Bottom Ash****	**Boiler Slag***	**FGD Gypsum****	**FGD Material Wet Scrubbers***	**FGD Material Dry Scrubbers***	**FGD Other***	**FBC Ash***	**CCP Production / Utilization Totals**
Total CCPs Produced by Category	**52,100,000**	**14,100,000**	**1,720,945**	**24,200,000**	**6,803,636**	**655,119**	**326,762**	**9,843,922**	**109,750,384**
Total CCPs Used by Category	**23,205,204**	**5,474,167**	**1,437,556**	**12,102,964**	**546,616**	**205,733**	**0**	**8,914,774**	**51,887,014**
1. Concrete/Concrete Products /Grout	11,779,021	732,260	0	63,607	0	5,372	0	0	**12,580,260**
2. Blended Cement/ Feed for Clinker	2,281,211	1,287,343	0	1,755,891	0	0	0	0	**5,324,445**
3. Flowable Fill	141,081	9,435	0	0	0	28	0	0	**150,544**
4. Structural Fills/Embankments	3,083,441	1,716,196	210,000	6,738	321,676	65,065	0	0	**5,403,116**
5. Road Base/Sub-base	193,711	352,469	1,300	31	0	0	0	0	**547,511**
6. Soil Modification/Stabilization	303,354	140,092	0	1,425	0	821	0	64,562	**510,254**
7. Snow and Ice Control	0	198,153	57,975	0	0	0	0	0	**256,128**
8. Blasting Grit/Roofing Granules	11,678	15,930	1,156,246	0	0	0	0	0	**1,183,854**
9. Mining Applications	2,086,074	437,986	0	1,181,799	224,940	118,868	0	8,762,464	**12,812,131**
10. Gypsum Panel Products	0	0	0	7,641,625	0	0	0	0	**7,641,625**
11. Waste Stabilization/Solidification	2,187,514	333	0	777,479	0	227	0	87,748	**3,053,301**
12. Agriculture	26,312	1,698	0	655,600	0	0	0	0	**683,610**
13. Aggregate	0	381,657	12,035	0	0	0	0	0	**393,692**
14. Oil Field Services	568,772	18,215	0	0	0	15,352	0	0	**602,339**
15. Miscellaneous/Other	543,035	182,400	0	18,769	0	0	0	0	**744,204**
Summary Utilization to Production Rate									
CCP Categories	**Fly Ash**	**Bottom Ash**	**Boiler Slag**	**FGD Gypsum**	**FGD Material Wet Scrubbers**	**FGD Material Dry Scrubbers**	**FGD Other**	**FBC Ash**	**CCP Utilization Total****
Totals by CCP Type/Application	23,205,204	5,474,167	1,437,556	12,102,964	546,616	205,733	0	8,914,774	**51,887,014**
Category Use to Production Rate (%)***	44.53%	38.82%	83.53%	50.00%	8.03%	31.40%	0.00%	90.56%	**47.27%**
2012 Cenospheres Sold (Pounds)	**23,104,970**	**This data represents 209, 598 MWs Name Plate rating of the total industry wide approximate 329,483 MW capacity (coal fueled) based on Ventyx data**							

The data received this year represents approximately 59 % of the coal consumed in 2012 by electric utilities and IPPs (approximately 821,400,000 tons)

* These are actual tonnages reported by utilities responding and **do not reflect estimates for utilities that did not respond** this year.

**These numbers are derived from previous, current and applicable industry-wide available data, including Energy Information Administration (EIA) Reports 923 and 860 and other outside sources.

***Utilization estimates are based on actual tons reported and on **extrapolated estimates only for fly ash, bottom ash, and FGD gypsum**;

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COAL ASH: A RESOURCE FOR RARE EARTH AND STRATEGIC ELEMENTS

By David Mayfield and Ari Lewis

Recently, prices of strategic minerals and rare earth elements have been rising dramatically due to global supply shortages and increasing demands. Strategic elements encompass a broad group of metals that are essential for emerging technologies (that is, important for technology, aerospace, and green energy industries) and have limited global supply chains. Several strategic metals are critical for components of energy-efficient technologies (refer to Table 1), including rare earth elements, gallium, germanium, indium, and tellurium.[1,2] Rare earth elements are a group of chemically similar metals including the 15 elements with atomic numbers 57 through 71, plus scandium and yttrium.[3] China is the primary global producer of many rare and strategic elements; however, global demands are outpacing current production volumes and many nations are initiating programs to identify alternative metal resources.[1-3]

The occurrence of trace concentrations of strategically important metals in coal and coal ashes has been understood for decades.[4-6] However, the economics of developing these resources have not been viable until recently, with the dramatic rise in metal prices.[7,8] Metal mine development, particularly for strategic elements, requires extensive capital investments and complicated regulatory oversight. The length of time from resource definition and completion of environmental permitting to production can span many years.[3,9] Further, as observed in China, if not properly controlled, beneficiation of metal ore deposits can result in unintended environmental consequences due to the release of chemicals used during mining and improper mine management.[9-11] Coal combustion waste storage facilities offer a potential source of strategic metals that may limit some of the expenses and environmental hazards associated with typical mine development. Therefore, it is worthwhile to explore environmentally sustainable methods to leverage existing coal ash deposits.

TRACE ELEMENTS IN COAL ASH

Raw, unprocessed coal contains a variety of metals and, in some cases, enriched concentrations of some strategic elements (Table 2). Surveys of coal resources indicate that some deposits may contain economically viable concentrations of rare elements.[7] In addition, the combustion process results in the enrichment of metal concentrations in the coal ash wastes, often several times the concentration found in raw coals (Table 2). While under certain conditions, some metals may leach from coal ash wastes (for example, As, B, and Se), many strategic metals remain bound to the ash residues.[17,18] The ranges of strategic metal concentrations

TABLE 1—EXAMPLES OF STRATEGIC ELEMENTS AND THEIR APPLICATIONS

Element	Atomic number	Example technology applications[1,2]
	Selected rare earth elements	
Yttrium (Y)	39	Phosphors, metal catalysts
Lanthanum (La)	57	Electric vehicles, phosphors
Cerium (Ce)	58	Electric vehicles, phosphors
Praseodymium (Pr)	59	Permanent magnets, electric vehicles
Neodymium (Nd)	60	Permanent magnets, electric vehicles
Europium (Eu)	63	Phosphors, light-emitting diodes
Terbium (Tb)	65	Phosphors, electric vehicles
Dysprosium (Dy)	66	Permanent magnets, vehicle batteries
	Other strategic elements	
Gallium (Ga)	31	Photovoltaics, semiconductors
Germanium (Ge)	32	Fiber-optics, semiconductors
Indium (In)	49	Photovoltaics, liquid crystal displays
Tellurium (Te)	52	Photovoltaics, thermoelectronic devices

in some coal ashes are similar to those from mineral ores, suggesting that coal ashes are possible resources for metal recovery.[3,7]

Limited information exists to characterize the concentrations of strategic elements in global coal ash storage facilities.[7,14] Seredin and Dai[7] estimated the rare earth ash content in U.S., Chinese, and Russian coal sources contained concentrations within the range of mineral ore deposits. Thus, the potential for using coal combustion products as a source for strategic elements is evident. However, due to the lack of trace element data, there is a need to characterize strategic element concentrations in worldwide coal combustion storage facilities. Further, it will be necessary to evaluate and prioritize these resources to focus efforts on those deposits with the highest amounts of strategic elements and those that can be effectively extracted from the coal ash matrix.

RECOVERY OF STRATEGIC METALS FROM COAL ASH

The recovery of metals from mineral ores, particularly strategic elements, is a complicated multi-step process that consumes energy and results in a variety of waste products.[3,9,19] This beneficiation process includes initial crushing and grinding of the ores to smaller particles, filtration and flotation to remove undesired minerals, and further conditioning prior to final metal purification.[3,9,20] By contrast, initial metal recovery from coal ash may be more efficient than ore processing because the physical form is more amenable to processing (that is, with limited initial conditioning). Methods for extraction and separation of individual strategic metals from fly ash are emerging and becoming more efficient as chemical engineering techniques are improved.

Several extraction techniques have been summarized for strategic metals.[8,14,19,21-23] Generally, these processes include initial acid leaching of ash material, followed by removal (for example, precipitation) of undesired minerals, and purification using solvent extraction. The leaching stage employs the use of low-pH acids (for example, hydrochloric, nitric, sulfuric, or oxalic acid) and varying temperatures and leaching times, depending on the composition of the fly ash. After leaching, removal of non-target minerals (for example, silicates, iron, or calcium) can be conducted using chelating resins or other precipitates (for example, calcium sulfate). Finally, the individual metal (for example, Ga or Ge) is purified from the solution using chemical extraction solvents. Extraction efficiencies can vary (for example, 50 to 99%) depending on concentrations of other elements in the fly ash or due to the nonspecific nature of some acids and extractants.[14,21] Chemical separation of rare earth elements can be more cumbersome. Due to the unique chemical similarity between this group of elements, multiple physical and chemical extraction techniques are typically employed to purify each metal.[19] Therefore, it is necessary to optimize the extraction technique for each coal combustion product source.[8,23]

TABLE 2—MEAN AND RANGE OF CONCENTRATIONS (MG/KG) IN COAL AND COAL ASHES

Element	Raw coal*	Coal ash†	Coal fly ash‡
Ce	20.9 (0.79 to 790)	468.78 (151 to 1784)	— (405 to 565)
Dy	2.09 (0.11 to 28)	61.54 (18 to 527)	— (32.1 to 50.3)
Eu	0.28 (0.025 to 5.8)	7.64 (2.00 to 31)	— (3.9 to 5.9)
La	9.09 (0.07 to 230)	259.85 (60 to 839)	— (206 to 286)
Nd	8.48 (0.47 to 230)	236.02 (70 to 967)	— (183 to 256)
Pr	4.81 (0.17 to 65)	59.02 (17 to 239)	— (49.0 to 68.4)
Tb	0.54 (0.01 to 21)	10.29 (3.00 to 80)	— (4.9 to 7.3)
Y	8.18 (0.10 to 100)	408.34 (94 to 3540)	— (191 to 259)
Total REE	54.9 (0.20 to 1031)	1723 (721 to 8426)	— (1213.6 to 1667.6)
Ga	5.24 (0.044 to 41)	Limited data	— (212 to 299)
Ge	4.23 (0.007 to 220)	— (<10 to 1841)	— (1.00 to 356)
In	0.71 (0.025 to 23)	Limited data	Limited data
Te	1.82 (8.8 to 510)	Limited data	— (0.14 to 2.7)

*Data represents detectable concentrations from unprocessed coal samples collected throughout the United States from 1973 to 1989 as summarized in the USGS COALQUAL.[12]

†Rare earth metal content estimated (from laboratory analyses) for ashes from coal deposits in the United States, Russia, China, and the Middle East summarized by Seredin and Dai.[7]

‡Range of concentrations measured from coal and coal fly ashes collected from power facilities in the United States, Europe, Mexico, and Spain.[13-16]

ENVIRONMENTAL CONSIDERATIONS

Pursuit of coal combustion residuals as a resource for strategic elements should be balanced with consideration of potential environmental benefits and impacts. While rare earth and other strategic elements are necessary components of energy-efficient and sustainable technologies, the process by which these materials are extracted results in the generation of multiple waste streams. If these new waste streams are properly managed, it should be clear that the development of coal combustion residues for strategic metals may provide an environmentally sustainable option to reduce the amounts of coal wastes in storage facilities. Thus, the management of wastes remains a necessary component of metal resource development.

Metal extraction and recovery, as described previously, is a chemically intense process.[9,19] Specifically, the metal separation steps will require the use of leaching acids, caustic precipitates, and organic solvents.[9] Each of these chemical components will need to be strictly maintained to limit unintended environmental releases or exposure to the facility operators. During metal extraction, multiple secondary waste streams are generated. Metal processing requires large volumes of water for the acid leaching stages.[9,19]

Electric vehicles utilize magnets that require several rare earth elements to manufacture.

While some of the water may be recycled and reused, a portion will need to be treated for contaminants. For example, coal ash residuals contain many trace elements (other than strategic elements) that are potentially toxic (for example, As, Hg, and Se).[24] The initial acid leaching process is generally nonspecific to trace elements; therefore, any remaining common elements will require recovery and disposal. Further, any residual naturally occurring radioactive or organic wastes (from acids or extraction solvents) will also require recovery and disposal. Because the retrieval of strategic metals from coal ash is still evolving and will need to be tailored to the specific characteristics of the coal ash source, the composition of the waste materials is likely to vary considerably. Further, these processes have yet to be commercialized; thus, our understanding of future waste streams is limited.

Further, existing environmental regulations are generally limited for the strategic metals industry. Specifically, occupational and environmental health standards have not been developed for most strategic metals or the specialty extraction solvents. This is largely due to limited information on the toxic effects of strategic metals on public health and ecosystems.[9] Further, the health and environmental effects from the release of these metals into the environment from all phases of development (processing, use, and disposal) is not well understood.[9] Therefore, as this industry expands, further research efforts may be required to generate the necessary toxicological information to develop safety recommendations. In addition, the potential for exposure (to workers, communities, or surrounding ecosystems) to any of the chemical contaminants inherent in this process is unknown; therefore, monitoring of environmental exposures may be needed as coal ash resources are reclaimed.

RESEARCH NEEDS

The future of advanced technologies and sustainable and efficient energy generation is dependent on the availability of a number of strategically important elements. One possible untapped resource that may alleviate supply risks for strategic metals is the significant availability of coal combustion waste products from coal-fired power plants. A number of research organizations are currently evaluating the processes to recover these strategic elements from coal ashes. As part of these investigations, it is necessary to consider the environmental risks associated with developing this resource. Additional research (as summarized in the following) is needed to identify environmentally sustainable solutions for processing strategic elements from coal ash.

- Limited existing information is available to characterize the strategic element composition of existing coal ash storage facilities. Further efforts should be initiated to survey and identify the coal ash deposits that are economically viable for metal recovery.
- Coal combustion product deposits that are identified as being potentially economically viable should undergo a full chemical characterization to determine which contaminants may require specialized waste handling measures. In addition, this characterization can be used as one metric to prioritize those

Strategic minerals and rare earth elements play a critical role in manufacturing components for an array of renewable energy technologies.

resources that have minimal concentrations of hazardous substances that require treatment and disposal.

- Further research and development is required to optimize the metal recovery and extraction process to minimize the use (or maximize recycling) of hazardous acids and solvents.
- Additional assessment of the public health and environmental risks of contaminants generated from coal ash processing should be undertaken. Specifically, additional data gathering on the toxicological effects from exposure to strategic metals or the chemicals used in their production would allow for informed development of safety recommendations.
- Finally, a thorough understanding of the potential routes of exposure and exposure concentrations generated during the various stages of coal ash processing is needed to protect occupational, public, and environmental health. ❖

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ASHPHALT PAVING: BETTER PERFORMANCE USING FLY ASH-AMENDED BINDERS IN ASPHALTIC CONCRETE

By Art Covi

Contrary to some opinions, fly ash isn't just another asphaltic concrete filler; it is a supplemental performance improvement additive that works in some of the same ways that fly ash makes better concrete for paving. Fly ash, with its spherical particles, size, and chemistry, is unique. It is not a common filler material like limestone or granite. ASHphalt, as we like to call it, is a bitumen binder oil amendment with strong economic benefits and with the capability of extending pavement life and performance. It can also help meet some increasingly important sustainability goals for society.

But first, let's look at some interesting background information. Asphalt paving is a multi-billion dollar industry in the United States. More than 500 million tons of asphaltic concrete is used annually for various pavement applications, including public roads and parking lots, private drives, and virtually all kinds of stockyards.

With over 2 million miles of paved roads and highways in the United States, asphaltic concrete accounts for 94% of total paved surfaces. According to the U.S. Department of Transportation (USDOT), the budget for roads was $16 billion for 2013, of which $14 billion was for repair and repaving.

Over the next 20 years, vehicle miles on roads are expected to grow by 50% and heavy trucking traffic is expected to double by 2025. New road-miles have only increased by approximately 5% in the last 20 years, but the quantity of vehicles has increased by nearly 95% during the same time. Heavy trucking volume is at an all-time high. The importance of building durable, long-lasting roads has never been more critical than today, coupled with the need to meet environmental sustainability goals and achieve resource conservation in the interest of society. And the strategic value of good roads has a direct impact on the nation's economy and commercial competitiveness.

The market for fly ash in ASHphalt applications could approach 2.5 million tons per year if used in all asphalt paving work in the United States. Even a part of this total for high-performance paving could represent a large beneficial use market for fly ash.

Improved performance of road paving and controlling the cost of construction and maintenance all contribute to good public policy and taxpayer value as well as economic benefits to private industry. Less repair work and the associated closed roads, longer service life for paving, and lower cost all contribute to sustainability, not to mention reduced driver inconvenience and aggravation.

Price volatility of oil, either imported or domestically sourced, has been painful in everyday life and has had a dramatic impact on the cost of oil-derived bitumen binders for paving as a direct result. The trend toward more expensive oil and oil by-products has been historically constant, and we can expect it to continue in the years ahead.

Continuous improvements to the performance and service life of road infrastructure have been a goal of innovative research throughout the transportation industry with an emphasis on using environmentally sustainable materials and methods. In this area of research, the unique qualities of fly ash produced at coal-fired power plants have

Figure 1. Asphalt concrete has a high content of coarse aggregates, which interlock to form a stone skeleton filled with a mastic of bitumen and filler; it is compacted on site to target 8% air void content to ensure the adequate performance under traffic and environmental conditions

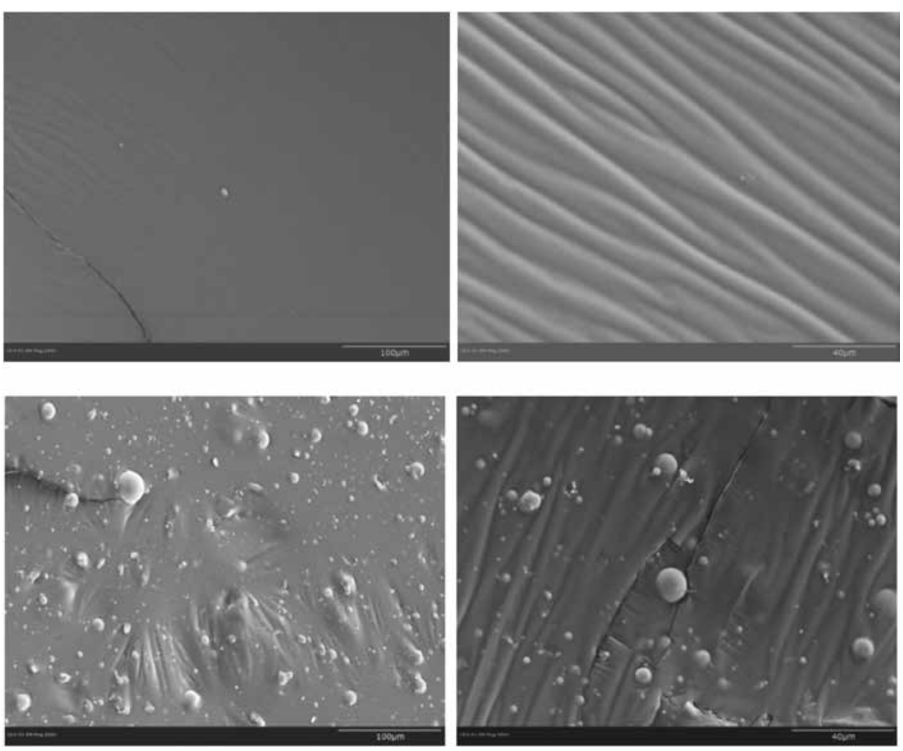


Figure 2. SEM images of low-temperature fractured bitumen/mastic specimens; Top: brittle failure of plain bitumen (PG-70-22); Bottom: crack pinning and crack deflection in ASHphalt specimens with 60% of fly ash; 200× (left) and 500× (right) magnification

been recognized internationally for years. Fly ash as a filler material in asphaltic concrete has been a topic for consideration but not a major emphasis in the industry. A new focus on bitumen binder amendment through the use of fly ash presents some attractive benefits beyond ordinary simple filler qualities.

Work has been done within the industry to improve bitumen binder performance through the years, although current practice involves polymer modification as the primary option to obtain high-performance oil binders. But the effects of expensive polymers on bitumen oil binder are very similar to fly ash, and fly ash is far more cost-effective. ASHphalt has the potential to increase the performance grade of asphalt binder oils and could become an alternate or complement to polymer modification.

ASHphalt, or asphaltic concrete, which includes fly ash for improved binder oil performance, has been studied at the

University of Wisconsin–Milwaukee (UWM) Center for By-products Utilization during the past 3 years in preliminary laboratory testing supported by We Energies. International studies over the past decade have also noted the unique performance of fly ash as a part of asphaltic concrete mixtures. A new 3-year supplemental research project through the Electric Power Research Institute under the P78 Beneficial Use of Coal Combustion Byproducts program was initiated in 2012 to test various fly ashes in asphaltic binder oils and demonstrate their effectiveness. The project scope also includes field installations using an ASHphalt pavement mixture design. An important feature of the new research is the evaluation of fly ash that is not suitable for portland cement-based concrete, potentially with high carbon or loss on ignition and/or sorbents. Scrubber-impacted ashes are also under testing, and show some potential for use in paving mixtures.

A clear advantage of fly ash beneficially used in ASHphalt from a regulatory point of view is the fact that this application is an encapsulated use of coal combustion products (CCPs), similar to current concrete uses, and it aligns well with potential future regulatory considerations. The rate of application may be less than 1% of the total asphaltic concrete by weight, while concrete typically uses between 2 and 4% fly ash.

Because fly ash also acts as a filler, it naturally extends the binder oil and can reduce the oil content in the asphaltic concrete mixture. This cost savings pays for more real paving work or can reduce the bottom-line cost to the owner. If a paver is offering lower cost and better performance for paving, ASHphalt can add competitive value.

Having spherical particles under 100 microns in size and its chemistry make fly ash unique in its ability to improve asphalt binder distribution and coating in aggregates and aid compaction in asphaltic concrete paving. Among many benefits, reduced stripping or loss of flexible binding performance over time helps to increase lifetime performance of asphalt paving. Fly ash-amendment of asphalt binder oils has been shown to increase the performance rating of oils, making them more flexible at low temperatures to resist cracking while adding stiffness at high temperatures to resist rutting. The same preliminary research indicates that fly ash improves moisture resistance of asphaltic concrete and resists aging in pavements.

How is ASHphalt produced? The same way that any asphaltic concrete is made: with a simple, precise addition of Class C or Class F fly ash to the mixture. No special handling is required in either the mixing or placement of the paving, and batch plants already manage fine powders as routine materials. Many asphalt batch plants have existing powder injection systems, which are used to add super-fines to the asphalt mixture.

Making better asphalt paving in the laboratory is interesting work, but the real test is putting it on the ground and rolling heavy trucks on it. We Energies paved 1.5 miles of heavy-haul road in 2012 at the Oak Creek Power Plant in Wisconsin with an ASHphalt mixture along with a standard asphalt mixture as a control section. Nondestructive testing with standard pavement methods (falling weight deflectometer) showed a 10% improvement in the elastic modulus for the ASHphalt section. What this simply means is that the paving has more capacity to sustain loads and recover without cracking—especially important for cold weather performance. This type of improvement could ordinarily be achieved through expensive polymers and higher-grade bitumen oils, but fly ash is far more economical.

The trial road paving at We Energies was funded by the company, but field test data are being used to verify UWM laboratory results. Regular periodic field testing will continue on the roadway. And at the conclusion of the 3-year research program, with great interest from the Wisconsin Department of Transportation, it is anticipated that a public highway will be paved using ASHphalt.

Another component of the EPRI research project is to determine the best way to incorporate fly ash into the mixture to optimize the performance advantages of ASHphalt. The team will work with batch plant operators and manufacturers to develop effective equipment to achieve this. The EPRI work will conclude with outreach efforts and technology transfer to share knowledge about the benefits and cost savings of ASHphalt with the paving industry.

Expanding the beneficial use of fly ash to more paving applications can serve many purposes, from the economic and performance perspectives and from environmental and recycling priorities. ASHphalt fits this strategy well.

For more information on ASHphalt, go to https://www.youtube.com/watch?v=GD5ksZ4ISjk. ❖

Art Covi is a Principal Engineer at We Energies, managing the Coal Combustion Products program at the Wisconsin-based utility company. We Energies has a long-standing record of beneficially using CCPs and developing new or expanded uses.

2013 CHAMPION AWARD

David Goss, Perennial Coal Ash Advocate, Receives ACAA's Highest Honor

David Goss, former Executive Director of the American Coal Ash Association, was awarded ACAA's highest honor during the Fall Meeting in Pinehurst, NC.

The ACAA Champion Award is given annually to an individual selected by the Association's Chair. Current Chair Lisa Cooper cited Goss's service both during his tenure as Executive Director and since then.

"Reportedly, as this precedes my active involvement in ACAA, Dave Goss restored confidence to the members of the Association, grew the Association, recruited diverse talent," Cooper said. "Dave would come out to meet you at your company, learn your issues, encourage involvement, and when he left, you knew you had a stalwart in your corner who felt deeply about your challenges and, more importantly, a confidant who would work with you with integrity and honor."

Goss retired in December 2008, just as the coal ash spill at the Kingston generating station in Tennessee changed the coal ash landscape dramatically. To assist ACAA in facing the challenge, Goss stayed on as a volunteer and consultant assisting the organization on several fronts.

"Dave has helped transition ACAA staff to support Tom and our monumental push in Washington to get nonhazardous designation under Subtitle D of RCRA, helped transition our inventory and staffing with CAM as we went with an association management company, attended meetings on behalf of ACAA as Tom can't be in all places, and most importantly has served as the face of CCP recycling as the lead of the ASTM E-50 effort to define best practices around structural fill," said Cooper. "Dave also continued to play an important role with the annual ACAA Production and Use Survey."

"Dave has said he totally wants to back away and pursue other things, but we will be in his heart and he will be there for any of us if he is needed," said Cooper. "Dave, I respect you and thank you for showing me how partial and full retirement can be done with grace and I thank you for being there always as our ambassador."

Goss is the second recipient of the newly created Champion Award. The first award was presented in 2012 by then ACAA Chair Mark Bryant to John Ward, who continues to serve as Government Relations Committee Chair and as a communications consultant to ACAA. ❖

American Coal Ash Association Chair Lisa Cooper presents the 2013 "ACAA Champion" Award to former Executive Director David Goss as current Executive Director Thomas Adams looks on.

IN & AROUND ACAA

WASHINGTON, DC

U.S. Senator Kay Hagan of North Carolina receives a product sample containing coal fly ash from Boral Material Technologies officials John Scoggan and Terry Peterson. Boral opened a facility manufacturing a new line of composite trim board in North Carolina. The company also hosted U.S. Congressman Melvin Watt at the facility, where he worked alongside Boral employees for an afternoon.

WASHINGTON, DC

American Coal Ash Association Executive Director Thomas Adams conducts ACAA's annual news conference, announcing the results of the Association's Coal Combustion Products Production and Use Survey. The news conference, held at the National Press Club, attracted coverage by energy, construction materials, and political media outlets. New to this year's news conference was the release of an eight-page brochure describing production and use trends—a copy of which is included in this issue of *ASH at Work.*

PINEHURST, NC

The American Coal Ash Association Women's Leadership Forum met during ACAA's Fall Meeting. Southern Company sponsored the event. The Forum is an informal group of ACAA women members whose broad goals are to develop interest and qualifications of women members for ACAA committee leadership and officer positions; to acquaint members with the wide range of energy and building materials careers; professional organizations and meetings with the goal of opening paths for further career development; and to promote professional interactions and camaraderie among members and women in related fields, including government, energy, building materials, and consulting.

LOUISVILLE, KY

State and national dignitaries attended a ribbon cutting as Charah opened a new, one-of-a-kind agricultural product development facility at the Mill Creek Generating Station. The $13 million facility will recover approximately 300,000 tons of power plant gypsum annually to create a unique sulfur product that will be sold to and distributed by agricultural companies. Pictured are Mike Kirkland, General Manager of LG&E's Mill Creek Generating Station; Paul Thompson, Chief Operating Officer, LG&E and KU Energy; Victor A. Staffieri, Chairman, CEO, and President of LG&E and KU Energy; Charles Price, President and CEO of Charah, Inc.; U.S. Senate Republican Leader Mitch McConnell; U.S. Senator Rand Paul; James Comer, Kentucky Commissioner of Agriculture; and Representative Rocky Adkins, Kentucky House Majority Floor Leader.

GEORGETOWN, SC

SEFA Group announced plans to construct a $40 million facility to recycle high-carbon fly ash from Santee Cooper's Winyah generating station. Using its proprietary STAR (Staged Turbulent Air Reactor) process, SEFA will reclaim up to 400,000 tons per year of ponded ash to produce a pure mineral product that provides greater strength and durability in concrete. SEFA introduced the STAR technology in 2011 and has installed two other plants, but this will be the first one equipped to use ponded ash.

ASH ALLIES

Utility Solid Waste Activities Group—The Front Line in Addressing Resource Conservation and Recovery Act Regulations for Coal Ash

USWAG

The Utility Solid Waste Activities Group (USWAG) is responsible for addressing solid and hazardous waste issues on behalf of the utility industry. A trade association of over 110 utility-operating companies, energy companies, and Industry associations, USWAG was formed in 1978 in the wake of the passage of the Resource Conservation and Recovery Act (RCRA) to represent the utility industry in working with the U.S. Environmental Protection Agency (EPA) as the agency began to develop regulations addressing the disposal of coal combustion by-products (CCBs).

USWAG's mission is to address the regulation of utility wastes, by-products, and materials in a manner that protects human health and the environment and is consistent with the business needs of its members.

USWAG supports the development of performance-based, nonhazardous waste regulation of CCBs implemented by the states. Such regulations would ensure the safe regulation of CCBs in a cost-effective manner, supporting the beneficial use of CCBs while protecting public health, the environment, and jobs.

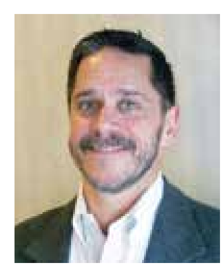
While USWAG's primary focus is on federal regulatory advocacy on environmental/solid/hazardous waste issues, as the policy debate has shifted to the legislative arena, USWAG has become increasingly active in legislative advocacy.

The coal ash issue provides a case in point. USWAG, closely aligned with ACAA in advocating for the regulation of CCB as nonhazardous waste, has been very active on Capitol Hill the past several congressional sessions, drafting legislation, preparing and delivering testimony, and in direct legislative advocacy in support of legislation that would implement enforceable, nonhazardous waste regulations to ensure the safe management of CCBs while supporting CCB beneficial use. The Coal Residuals Reuse and Management Act (H. 2218), which passed the House in July 2013, is the only mechanism under consideration that would implement such requirements; USWAG continues to work with ACAA and other allies to encourage Congress to pass this critical legislation. USWAG repurposed a grassroots, "take-action" webpage, originally developed to allow individuals to submit comments on EPA's June 2010 proposed ash rule, to allow individuals to contact Congress to urge enactment of H. 2218: **www.regulatecoalashright-now.org**. USWAG's comments on the proposed rule and the legislation, along with those of other stakeholders, may be found at **http://www.uswag.org/ccbletters.htm**.

In addition to the CCBs, USWAG is engaged in a variety of solid and hazardous waste regulatory issues affecting utility operations and engages in advocacy pertaining to RCRA, the Toxic Substance Control Act (TSCA), and the Hazardous Materials Transportation Act (HMTA).

The major policy-making body of USWAG is its Policy Committee, and there are a number of technical committees and task forces which implement the decisions of the Policy Committee, including the Ash Management and Solid Waste Committee (responsible for addressing EPA's regulatory determination, RCRA reauthorization, Subtitle C rulemakings, ash use activities, and clean coal technology by-products); the Low-Volume Waste Committee (responsible for used oil regulations, hazardous waste burning rules, mixed waste, RCRA Subtitle C rulemakings, lighting wastes, land disposal restriction regulations, and universal waste management standards); the Treated Wood Subcommittee (addresses regulations affecting the use and management of used, treated utility wood poles and cross-arms); the PCB Committee (responsible for PCB use and disposal and PCB spill cleanup); the Remediation and Response Committee (addresses regulations affecting the management of remediation wastes generated during site cleanups); the Tanks Subcommittee (responsible for underground tanks, aboveground tanks, and SPCC regulations); and the DOT Committee (responsible for DOT Hazardous Materials Regulations and HMTA reauthorization).

USWAG is headed by Executive Director Jim Roewer, who has worked for USWAG since 1990. Roewer has been involved in science and environmental policy issues since graduating from the School of Public and Environmental Affairs at Indiana University with his BA in biology from Wittenberg University and his MS in environmental science. Gayle Novak supports USWAG's mission in her position as Manager of USWAG Program Services. In addition, Venable LLP, USWAG's counsel, supports USWAG members' interests with decades of experience in regulatory and legislative advocacy, litigation, and regulatory analysis/interpretation and compliance assistance. ❖



COAL ASH RECYCLING DECLINES AS REGULATORY UNCERTAINTY CONTINUES

Annual ACAA Production and Use Survey Documents Disturbing Trend

Coal ash recycling in the United States declined by 4.7 million tons in 2012. For the fourth consecutive year, ash use remained below 2008 levels—stalled after nearly a decade of growth of a practice that conserves energy and natural resources, reduces greenhouse gas emissions, and safely keeps ash out of landfills and disposal ponds.

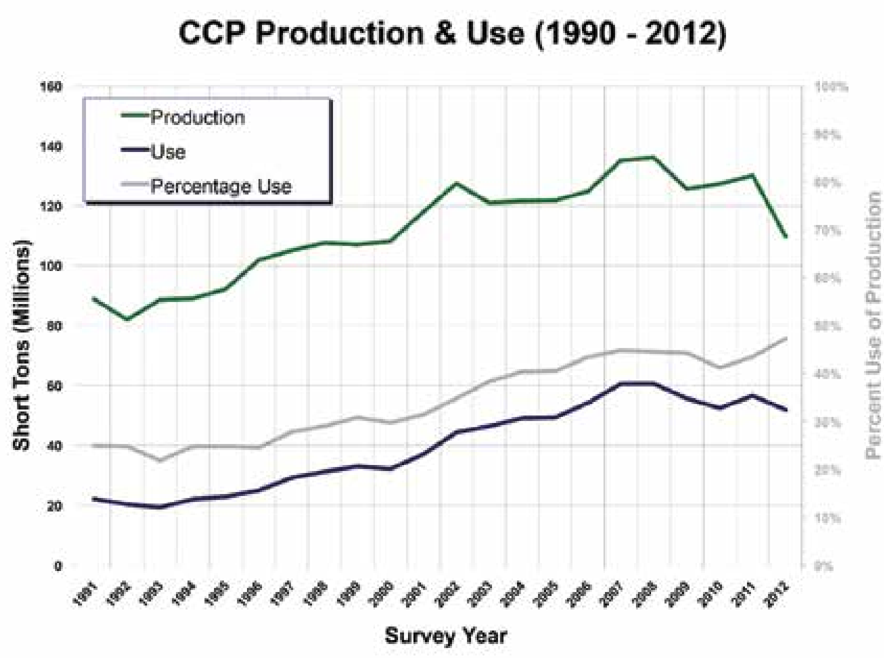
The turnaround occurred as the U.S. Environmental Protection Agency (EPA) proposed coal ash regulations that could designate the material as "hazardous waste" when disposed. Growing numbers of ash producers, specifiers, and users have restricted coal ash use in light of the regulatory uncertainty and publicity surrounding the EPA's activities.

"Although we are encouraged by recent EPA statements that the Agency currently thinks 'nonhazardous' coal ash disposal regulations are appropriate, the protracted debate continues to impede recycling," said Thomas H. Adams, Executive Director of the American Coal Ash Association (ACAA), an organization that advances the environmentally responsible and technically sound use of coal ash as an alternative to disposal. "People don't just wake up one day and decide to recycle more. It takes planning and investment that are difficult to justify in an environment of regulatory uncertainty and misleading publicity about the safety of coal ash. The loser, unfortunately, is the environment, as millions more tons of coal ash needlessly wind up in landfills."

According to ACAA's just-released "Production and Use Survey," 51.9 million tons of Coal Combustion Products (CCPs) were beneficially used in 2012—down from 56.6 million tons in 2011 and well below the 2008 peak of 60.6 million tons. In the closely watched category of fly ash used in concrete, use remained level at 11.8 million tons, up by only 44,000 tons over 2011 and still below 12.6 million tons in 2008.

"The irony of the lengthy debate over coal ash disposal regulations is that the debate is causing more ash to be disposed," said Adams. "If the past 4 years had simply remained equal with 2008's utilization, we would have seen 25.9 million tons less coal ash deposited in landfills and impoundments."

The decline in recycling volumes stands in stark contrast to the previous decade's trend. "In 2000, when the recycling volume was 32.1 million tons, the EPA issued its Final Regulatory Determination that regulation of ash as a 'hazardous waste' was not warranted. Over the next 8



In this issue of *ASH at Work*, see a special eight-page brochure insert on the 2012 production and use data. Additional printed copies of the brochure are available by contacting the ACAA office.

years, EPA also began actively promoting the beneficial use of coal ash and the recycling volume soared to 60.6 million tons."

Recycling stalled after 2008 as the EPA reopened its coal ash regulatory agenda following the failure of a coal ash disposal facility in Tennessee. "Supporters of a 'hazardous waste' designation for coal ash disposal like to say that higher disposal costs will lead to more recycling. This real-world evidence—coupled with the growing list of people ceasing the use of coal ash—completely contradicts that simplistic argument," said Adams.

"The fact is that coal ash disposal costs did not change much between the 1990s and 2000s," Adams continued. "What caused the dramatic growth of recycling in the 2000s was regulatory certainty that encouraged people to invest in recycling rather than disposal and a supportive EPA that actively encouraged recycling. All of that is gone now. EPA's 'Final' Regulatory Determination turned out not to be 'Final' and anti-coal groups lobbying for a 'hazardous waste' designation churn out a steady stream of misleading publicity regarding the safety of coal ash."

Adams noted that coal ash does not qualify as a "hazardous waste" based on its toxicity and that the trace levels of metals in coal ash are similar to the levels of metals in the materials coal ash replaces when it is recycled. An ACAA study released in June 2012 analyzed recent U.S. government information to show that concentrations of metals in coal ash, with few exceptions, are below environmental screening levels for residential soils and are similar in concentration to common dirt.

ABOUT COAL ASH RECYCLING

Coal remains the largest fuel source for generating electricity in America and produces large volumes of coal ash—the generic term for several solid materials left over from the combustion process.

There are many good reasons to view coal ash as a resource, rather than a waste. Recycling it conserves natural resources and saves energy. In many cases, products made with coal ash perform better than products made without it. For instance, coal ash makes concrete stronger and more durable. It also reduces the need to manufacture cement, resulting in significant reductions in greenhouse gas emissions—approximately 11 million tons in 2012 alone.

Major uses of coal ash include concrete, gypsum wallboard, blasting grit, roofing granules, and a variety of geotechnical and agricultural applications.

ABOUT ACAA'S PRODUCTION AND USE SURVEY

The American Coal Ash Association has conducted a survey quantifying the production and use of coal ash in the United States each year since 1966. Data is compiled by directly surveying electric utilities and using additional data produced by the U.S. Energy Information Administration. The survey's results have been widely used by federal agencies, including the EPA and U.S. Geological Survey. ❖

Mark your calendar for:

ACAA Winter Meeting, February 4 and 5, 2014

The American Coal Ash Association will gather for its winter meeting in Albuquerque, NM. Founded in 1706, Albuquerque is the largest city in New Mexico and the 53rd largest city in the United States. The city has a desert climate and lies in the Rio Grande Valley. It has a vibrant fine arts community and is a center for numerous research laboratories. Approximately 100 miles to the north is Los Alamos, the site of the development of atomic and hydrogen bombs.

The meeting will follow a traditional format, with committee meetings on Tuesday, February 4, and presentations on topics related to beneficial use on Wednesday, February 5. A welcome reception will be held on Tuesday evening. The host hotel for the meeting is the Hyatt Regency Albuquerque. For more information, please visit the ACAA website or contact Alyssa Barto at +1.248.848.3816.

Ash Utilization Workshop, April 29 and 30, 2014

Coal combustion products (CCPs) are beneficially used in a wide variety of applications. CCPs can be found in use on farms, construction sites, and mines in the United States and around the world. Beneficial use of CCPs helps control costs, creates better products, and helps create a more sustainable community. The Center for Applied Energy Research (CAER) and the American Coal Ash Association (ACAA) will co-host an Ash Utilization Workshop in Lexington, KY, in late April. The workshop is intended to provide an overview of CCPs in beneficial use. Expert speakers from across the beneficial use industry and the CAER will present information on specific types of CCP, how they are generated, and how they are used. This is an excellent opportunity for those who have had limited exposure to the wide variety of CCPs to learn of the diverse markets for CCPs. For more information, please contact Alyssa Barto at +1.248.848.3816.

MEET YOUR LEADERSHIP

Editor's Note: Meet Your Leadership is a new recurring feature of *ASH at Work.* Each issue will introduce elected officers and directors from the utility, marketer, and associate membership categories. The following ACAA members currently serve on the Executive Committee.

UTILITY

Kenneth Tapp, LG&E and KU Services Company

Tapp has lived his entire life in Louisville, KY. He joined Louisville Gas and Electric Company in 1977 as a helper in the coal handling department at the Cane Run Power Station and was promoted to the coal handling supervisor position in 1981. He was transferred to the newly commissioned Trimble County Power Station in 1989 as Coal Handling Supervisor. Tapp was transferred to the main offices of Louisville Gas & Electric and Kentucky Utilities in 1997 and was promoted to his current position of Senior By-Products and Industrial Coal Sales Coordinator in 1999. His duties as Industrial Coal Sales Coordinator include purchasing, arranging transportation, and reselling coal to industries that use coal in the Louisville area. His responsibilities as by-products coordinator include identifying beneficial use opportunities for the coal combustion products produced at seven power plant locations. Tapp received his bachelor's degree in business administration from Bellarmine University, Louisville, KY, in 1997. ❖

MARKETER

Gary England, Headwaters Resources, Inc.

England was appointed Vice President of Headwaters Resources, Inc., in June 2003, after joining the company a year earlier. At Headwaters Resources, he is responsible for the marketing and management of coal combustion products in excess of 5 million tons annually. He has been involved in the implementation and use of high-volume fly ash throughout the western United States, resulting in multiple changes to specifications using fly ash. Prior to his position at Headwaters, England spent over 25 years in various senior executive level positions within the transportation and logistics industry, designing and operating logistic and material handling systems for residual fuels and industrial by-products. England received his bachelor's degree in business from the University of Nebraska-Lincoln, Lincoln, NE, in 1980. ❖

ASSOCIATE

Christopher D. Hardin, P.E., CH2M Hill

Hardin is a geotechnical and environmental professional engineer with over 24 years of experience in the technical and business management aspects of responsible waste handling, renewable energy, and sustainable agriculture. He is the Coal Combustion Practice Leader of CH2M HILL and a Senior Fellow at the IDEAS Center at UNC Charlotte. He graduated from the University of Maryland in 1987 and is a registered professional engineer in seven states. Hardin started and successfully ran a 25-person engineering company for 9 years that specialized in landfill design, coal combustion by-product containment design, construction quality assurance, groundwater remediation, and forensic evaluation of failing geotechnical projects. Subsequently, he worked for several national engineering firms as national client service manager, engineering design team leader, national practice leader, and senior project manager for solid waste, coal ash containments, and international sediment remediation projects in both the U.S. and China. ❖

ASH CLASSICS

Coal Ash in Dams and Bridges— A Long (and Durable) History

By Dave Goss, Former ACAA Executive Director

"Ash Classics" is a recurring feature of ***ASH at Work*** *that examines the early years of the National Ash Association (NAA) and issues and events that were part of the beneficial use industry's defining years.*

This issue of Ash Classics addresses "heavy" and "lengthy" subjects—dams and bridges. As I will demonstrate, for these two topics, some things just naturally go together: dark chocolate and red wine, and fly ash in concrete.

We are all familiar with the use of ash in ancient structures such as the Pantheon. Ash use in the United States is historic, as well. In 1937, the *ACI Journal* published a paper titled "Properties of Cements and Concretes Containing Fly Ash." The technical information contained in that paper confirmed that fly ash was very suitable for mass curing conditions and applications to reduce the heat of hydration, such as in dams and other large concrete structures. The repairs to the spillway of the Hoover Dam in 1942 were the first major use of fly ash concrete by the Bureau of Reclamation (BOR). Another BOR project, the Hungry Horse Dam in Montana, completed in 1952, used more than 1.3 million yd^3 of fly ash concrete and was the first large-scale dam built with fly ash concrete.

Babcock

The acceptance of fly ash in concrete continued, and by the time the National Ash Association (NAA) was formed, there were abundant examples of fly ash concrete uses. NAA's intrepid journalist editor of *Ash at Work*, Alan Babcock, included examples of concrete projects in every issue.

In 1971, he provided an article about the construction of a large spillway at the LaCygne Plant in Kansas and its use of over 18,000 yd^3 of fly ash concrete. However, NAA did not limit its technical coverage to just traditional concrete. In an early *Technical Bulletin* (Number 14), the use of fly ash in a flowable fill for bridge abutments in West Virginia introduced this application to readers. Two bags of ash for each bag of cement combined with water, bentonite, and clay created slurry that helped stabilize the bridge itself.

In 1972, *Ash at Work* reported on the construction of the Grand Coulee Dam power house and forebay in northeastern Washington. This project used over 98,000 tons of fly ash in a 94 pound of ash per yd^3 mixture design. Again, the Bureau of Reclamation oversaw the project and was completely satisfied with the results. The picturesque and impressive New River Bridge in south central West Virginia was an example of an innovative use (at that time) of fly ash in bridge construction. The bridge spans the New River Gorge above the abandoned workings of the Ames Coal company. To ensure that the footings for the bridge piers were stable, a grout mixture of three parts fly ash to one part of cement was injected into a truncated cone-shaped area that came in contact with the mine roof. This process added strength to the pier structure and helped prevent subsidence.

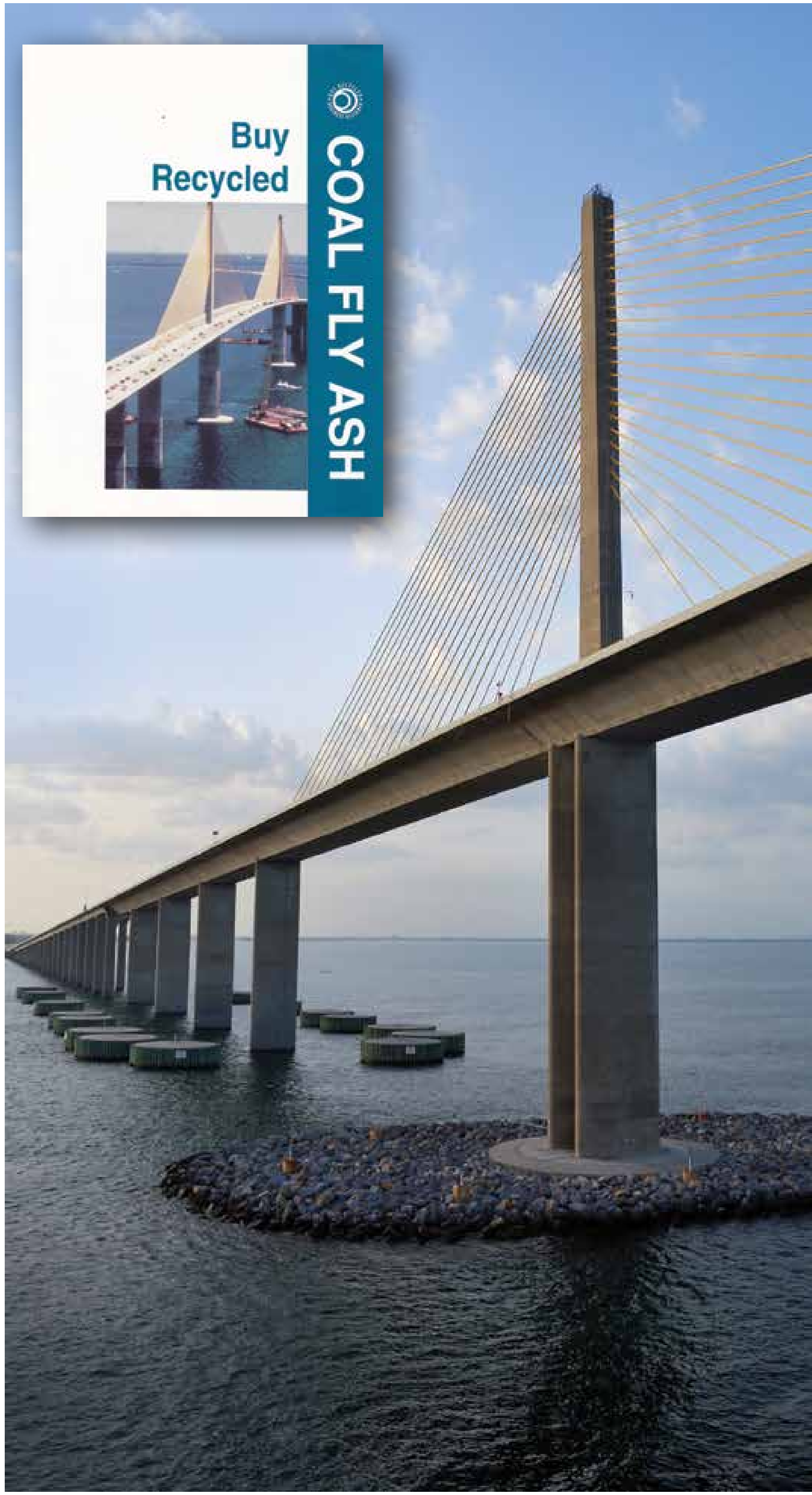
Numerous other projects were reported in *Ash at Work* over the years, which described unique, innovative, or sound engineering. The Bath County Pumped Storage Hydroelectric Project (West Virginia) used nearly 60,000 tons of fly ash in the power house and tunnels, as described in 1981. In 1984, *Ash at Work* covered the story of the Upper Stillwater Dam in central Utah, a roller-compacted concrete (RCC) structure. This was NAA's first article on RCC dams and the dam's use of a mixture design of 50% replacement was rather unusual 30 years ago. However, subsequent RCC projects have more than matched this project and include the Olivenhain Dam in California and dams in Pakistan, India, and Europe.

Many members will recall the striking flyer "Buy Recycled Coal Fly Ash" that ACAA published in the late 1980s. The cover of this flyer features an aerial photo of the Bob Graham Sunshine Skyway Bridge in Tampa, FL. This 4.1-mile-long, cable-stayed bridge used fly ash concrete during its construction. A floating batch plant was used to mix the concrete. The spectacular image of the structure and its views from the roadway has made this bridge a favorite of writers and bridge aficionados. From a technical perspective, however, it demonstrates the value of using fly ash concrete in relatively harsh marine conditions. In 1987, this might have been a bit unusual, but today, it is an ancestor to other famous counterparts. The Arthur Ravenel Jr. Bridge in Charleston, SC, was the cover photo of Issue 1 of the 2009 *Ash at Work*. This bridge is the third longest cable-stayed bridge in North America and was constructed using high-volume fly ash concrete mixtures in just over 3 years. The high-performance characteristics of high-volume fly ash concrete enabled the contractors to use a number of innovative construction practices and techniques that allowed work to be completed in a relatively short time for a bridge of this proportion.

More recently, the East Span of the San Francisco-Oakland Bay Bridge is using another innovative feature—greener concrete. CalTrans is requiring concrete used on the structure to contain fly ash as both a performance-enhancing material and a way of reducing carbon emissions. Like other CalTrans specifications, fly ash is deemed to contribute to a lowering of greenhouse gas emissions by not using as much portland cement in mixture designs. Also, the fabrication of 452 precast concrete segments, which are transported separately to the structure, allows for faster work schedules.

Looking back at over 45 years of CCP reporting, we find that fly ash concrete has played a significant role in countless projects, many of them high-visibility. Yet, the use of fly ash in many of these projects lies "below the surface" of information provided on these projects. At the time, the use of fly ash might have been innovative or less common. Today, it has become a norm, especially in many large-scale projects that consume large quantities of concrete. The characteristics of concrete containing fly ash contribute to the reduction of heat of hydration, the reduction of porosity (very important in marine and aquatic settings), and durability over long periods of time. The early publicity provided by NAA and ACAA was revealing and helped promote the growth of the industry.

In closing, I think Al Babcock would be most pleased to know that ACAA is continuing the coverage of traditional and innovative uses for CCPs in *Ash at Work*. However, I am not sure that this Mountaineer would be at all happy to know that his beloved football team would be playing Red Raiders, Wildcats, and Jayhawks instead of the perennial foes of the Southern and Big East Conferences. I wonder if Al would think this kind of press coverage might not be so good. ❖



SAVE THE DATE!

ASTM International Committee C09 on Concrete and Concrete Aggregates

100th Anniversary Celebration 1914-2014

A celebratory dinner and reception will be held during the June 2014 Committee Week in Toronto, Ontario (C09 will meet June 22-25).

Exact date and details to follow. Contact Scott Orthey (sorthey@astm.org).

www.astm.org/COMMIT/C09

ASTM INTERNATIONAL
Standards Worldwide

Host Ash Utilization Workshop

The Center for Applied Energy Research (CAER) and the American Coal Ash Association (ACAA) will host a workshop on coal ash use on April 29 and 30, 2014 in Lexington, KY. The workshop will offer a comprehensive overview of coal combustion products (CCP) from the point of generation to inclusion in buildings, agriculture, infrastructure, and environmental remediation projects. The event is targeted at those who wish to increase their knowledge of the materials and opportunities for recycling. Generators, marketers, consultants, public officials and students will find this workshop valuable in understanding the scope of CCP use and issues related recycling.

Expert speakers from the CAER and industry will make the presentations. Among the topics to be addressed are the following.

- Disposal or beneficial use? The basic decision to capture the inherent value of these materials drives all other topics. If CCP has value, why would a generator dispose of it?
- How much CCP is produced? How much is used? Since 1968 the ACAA has tracked production and use of CCP. Decades of data collection demonstrate the history of successful CCP recycling.
- CCP characterization – What tests are used to evaluate each CCP? What is the significance of the test results? What are the limitations of these tests? What do the tests tell us?
- CCP uses – What markets use CCP and why? What materials compete with CCP?
- What environmental challenges are associated with CCP recycling?
- CCP and Sustainability – What makes CCP recycling a sustainable solution?
- What is the future for CCP use? Will there be CCP available in the future? What is "green mining?"

The first Ash Utilization Workshop was held in 2012. According to ACAA Executive Director Thomas Adams, "The response of the attendees at the first event convinced us that we needed to offer this event again in 2014. The World of Coal Ash (WOCA), the flagship event for our industry, is held every other year. Some people were not able to attend WOCA to get this information and did not want to wait for the next WOCA. To serve that demand, CAER and ACAA responded with this event. The workshop has a less formal structure than is possible at WOCA, allowing for an examination of issues between speakers and attendees. It also provides the very latest updates on CCP recycling."

For more information on the 2014 Ash Utilization Workshop, visit the CAER website at **http://www.caer.uky.edu/ash2014/home.shtml** .